Space Weather Technical Forecast

Issued on Friday, 29 March 2024 at 12:48 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares expected from AR3615 (R1-R2 Blackouts). Chance of X-flares (R3+ Blackouts). Activity easing day 4 (01 Apr).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with the greatest intensity flare a double-peaked X1.1 (and M9.7) with peak at 28/2056 UTC from AR3615. Two further M-flares were also observed from AR3615 including an M6.1 at 28/1540 UTC and M3.2 at 29/0230 UTC. There are four sunspot regions on the visible disc, all in the western hemisphere, and besides AR3615, small and simple unipolar spots. AR3615 is a very large and relatively complex region that is now moving close to the west limb, leading to difficult viewing for analysis. However development appears ongoing with the trailer spot, and there are still identifiable delta-spot configurations.

The X1.1 flare produced a very weak and slow CME that has been assessed as missing Earth. A further CME was also observed from the M3.2 flare, and while assessment is still ongoing, this is also currently expected to miss Earth. No other Earth-directed eruptions have been observed, however a large and mobile filament is present on the southeast solar disc, and will need monitoring from any lift off.

Solar Wind / Geomagnetic Activity: The solar wind measured by ACE at L1 was indicative of ongoing ambient slow wind conditions. Winds speeds eased from slightly elevated, around 430km/s to background 360 km/s, with density below average. Interplanetary Magnetic Field, Bt, was weak below 5nT, with north-south component, Bz also weakly varying between +4 and -2nT. The phi angle was positive (away from the Sun) at first, but became more variable in direction from 28/1630 UTC. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) remained slightly above background, but well below the S1 Minor Radiation Storm level, and still easing after the S2 Moderate Storm that peaked 24 Mar. High energy electron flux (greater than 2MeV) observed at GOES16 was mostly at background, but briefly rising to be occasionally Moderate between 28/1300-2300 UTC. The associated 24-hour fluence remained below Active, with a value of 5.46e6 integrated pfu at 29/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity with further M-class flares expected, and a chance of isolated X-class flares from AR3615. This risk recedes later in the period, as the region moves onto the far-side later day 2 (30 Mar), although any notable flares will potentially remain observable into day 4 (01 Apr).

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Background winds at first have the potential to become slightly enhanced day 3 (31 Mar) from the arrival of any fast wind from CH15/+. Any connection to this feature is expected to be limited however. Mainly Quiet geomagnetic activity forecast, with a chance of Unsettled, and a slight chance of Active intervals with the onset of the fast winds.

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES18, is expected to continue easing to background in the absence of any notable flares from AR3615.

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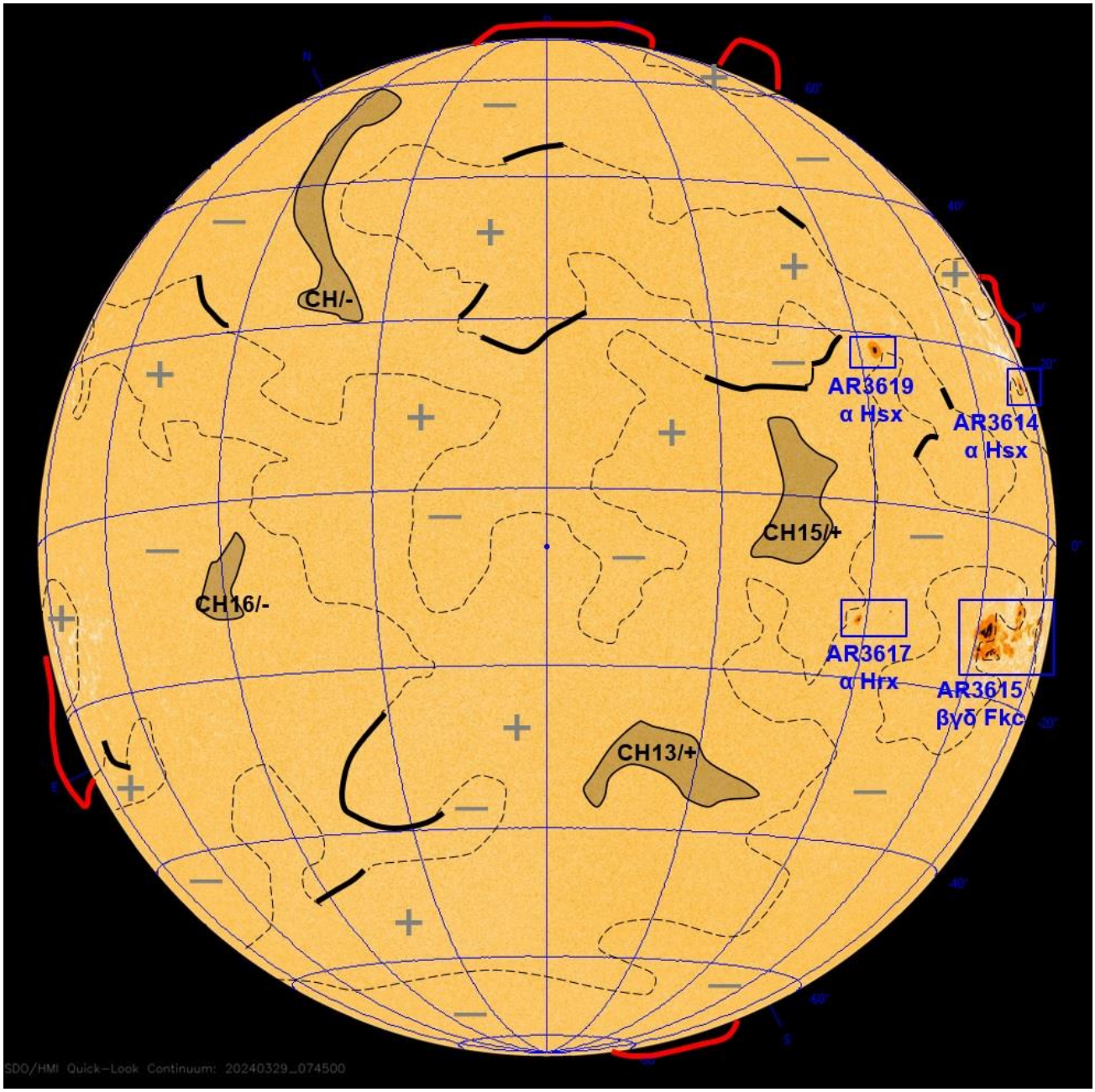
There is a slight chance of a further enhancement above the S1 level given any strong flares from this region. High energy electrons are likely to continue at Low to Moderate levels, with a slight chance of reaching High. The associated 24 hour fluence is expected to remain below the Active threshold, but with a slight increasing trend.

Figure 1. Solar Analysis Valid 29/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

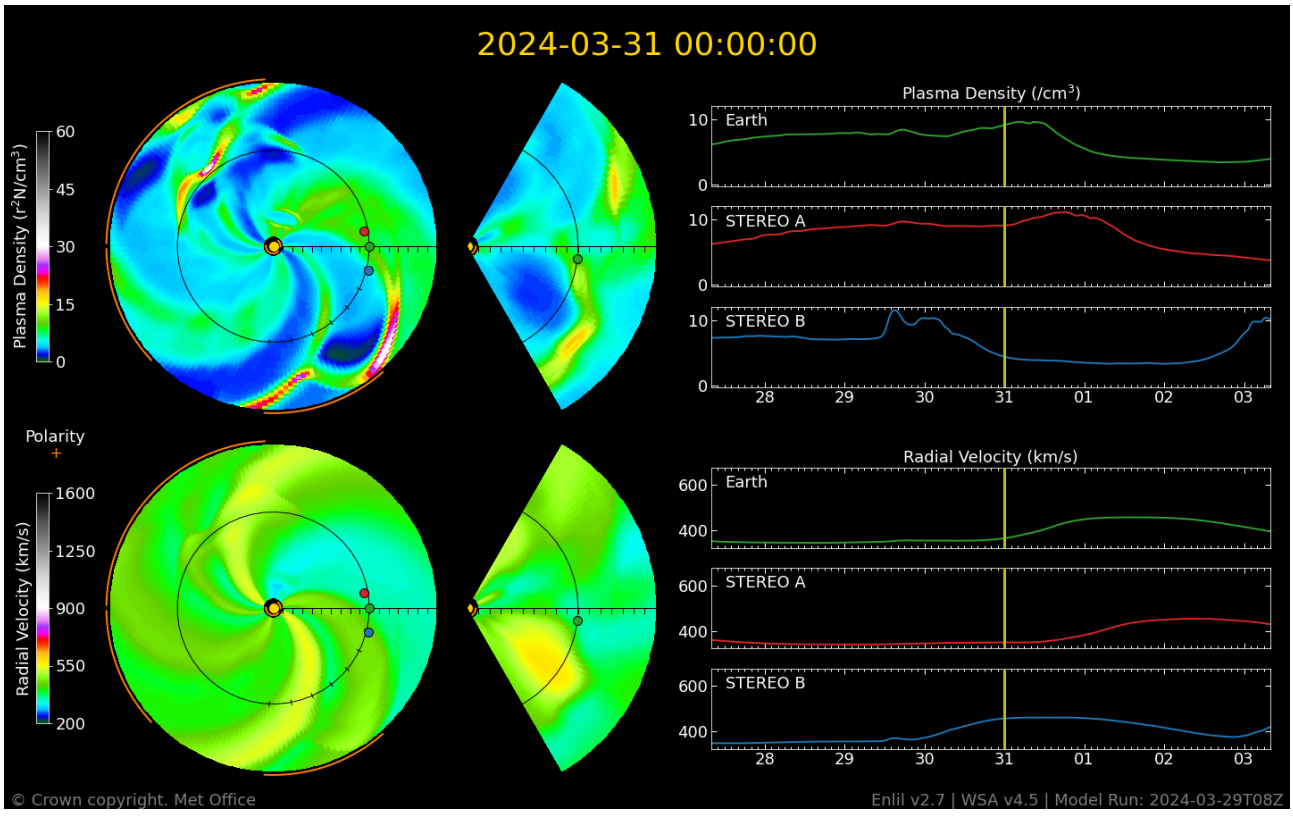
There are no Earth-directed CMEs.

Ambient slow wind conditions are expected at first. A slight enhancement to speeds is likely on day 3 (31 Mar) due to the arrival of any fast wind associated with CH15/+. However, this is a small, non-recurrent feature and not favoured for connection at this time of year due to its positive polarity. Only a limited enhancement is expected, which is supported by MOSWOC Enlil.

Geomagnetic activity is expected to be mainly Quiet days 1-2 (29-30 Mar), but with the chance of a spell of Unsettled on day 3 (31 Mar), peaking with isolate Active intervals, before easing again day 4 (Apr 01).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil Showing weak enhancement from CH15/+



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Radio Blackouts - X-Ray Flares:

Moderate to High activity is expected days 1-2 (29-30Mar) with further M-flares or an isolated X-flare possible from AR3615 as it approaches the west limb. There is a very slight chance of an X10+ flare (R4 Blackout). Confidence then decreases on day 3 (31 Mar) as this region rotates away over the limb, but still with a risk of any large flares being observable. Activity likely eases to be Low day 4 (01 Apr).

AR3615 dominates the flare forecast, as a very large and relatively complex spot, although the complexity of the region is becoming harder to assess as it approaches the western limb. Some clear dynamical evolution and potential growth was evident within its trailer however, and this was the likely source of the recent flare activity. There are three other small and simple sunspot regions on the disc, all in the western hemisphere, however these are mature and stable regions and unlikely to be sources of notable flare activity.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	80	70	60	30
Very Active	R3 to R5 X Class	Yes	30	30	20	5

Figure 3a: GOES-16/18 X-ray flux

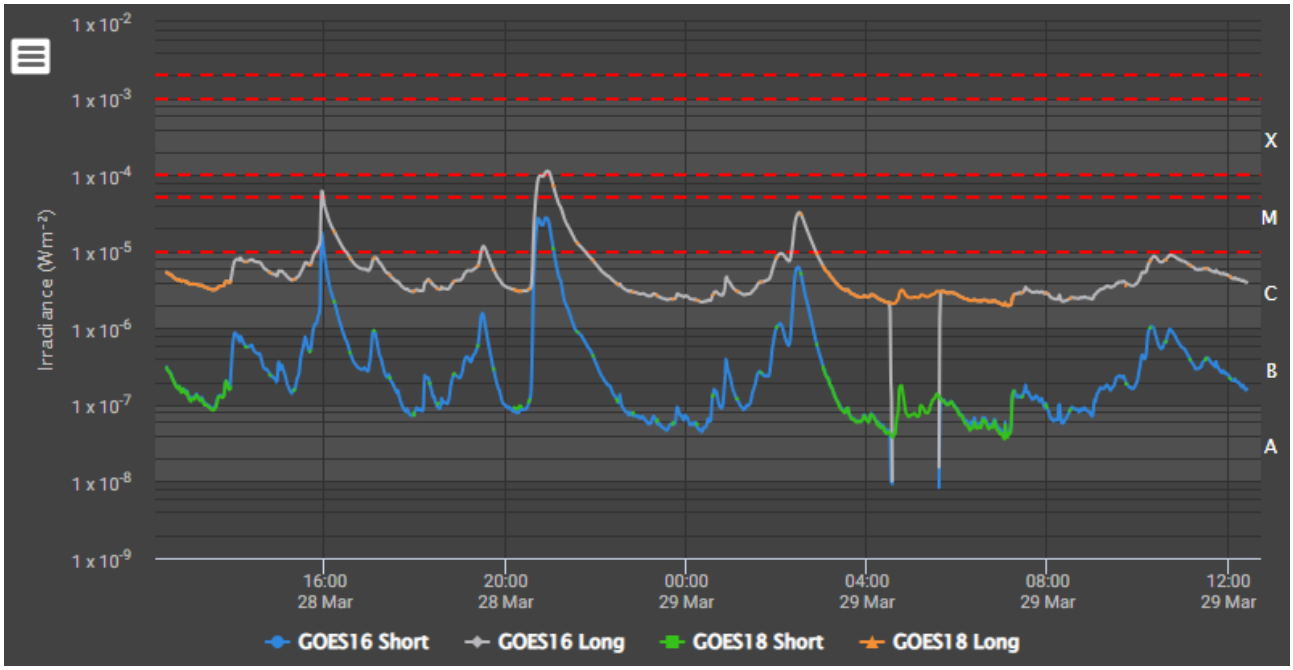

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Figure 3b: SDO imagery of AR3615 at time of issue (Top: Intensitygram, aia-94, aia0211. Bottom: magnetogram, aia-171, aia-304). Complex looping and magnetic structure evident as the spot rotates towards the west limb.

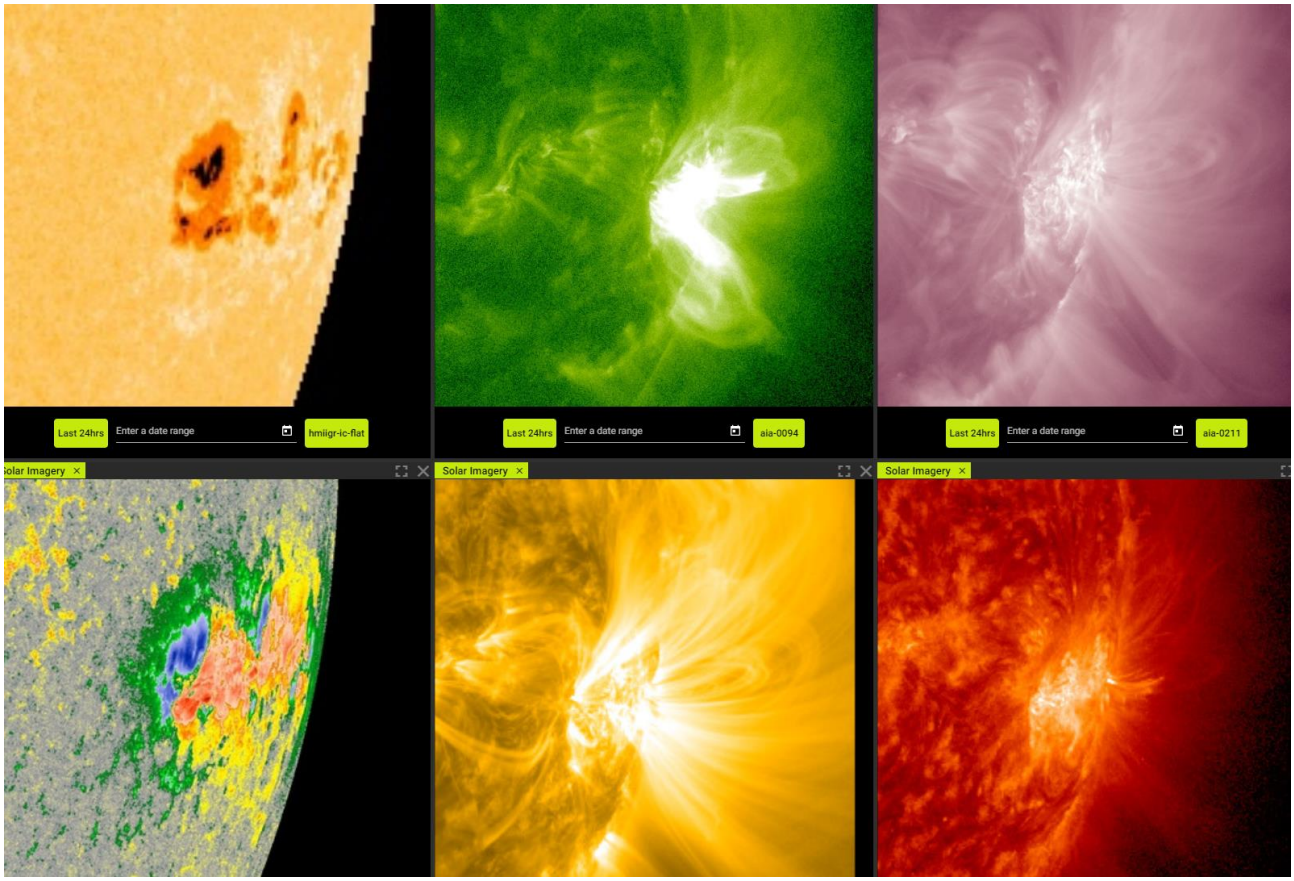
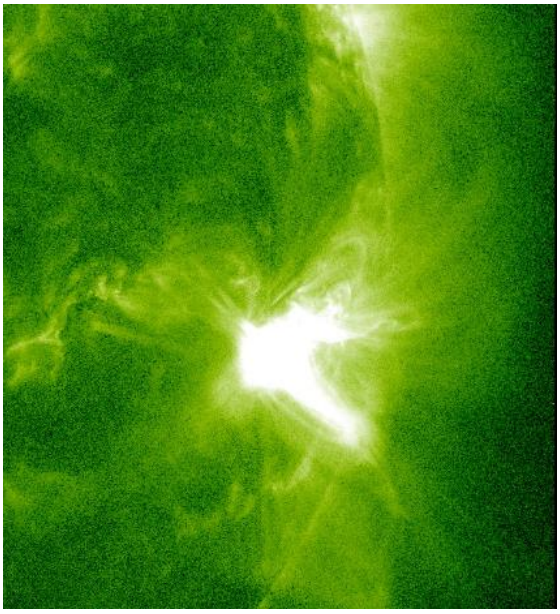


Figure 3c: SDO aia-94 of the X1.1 flare



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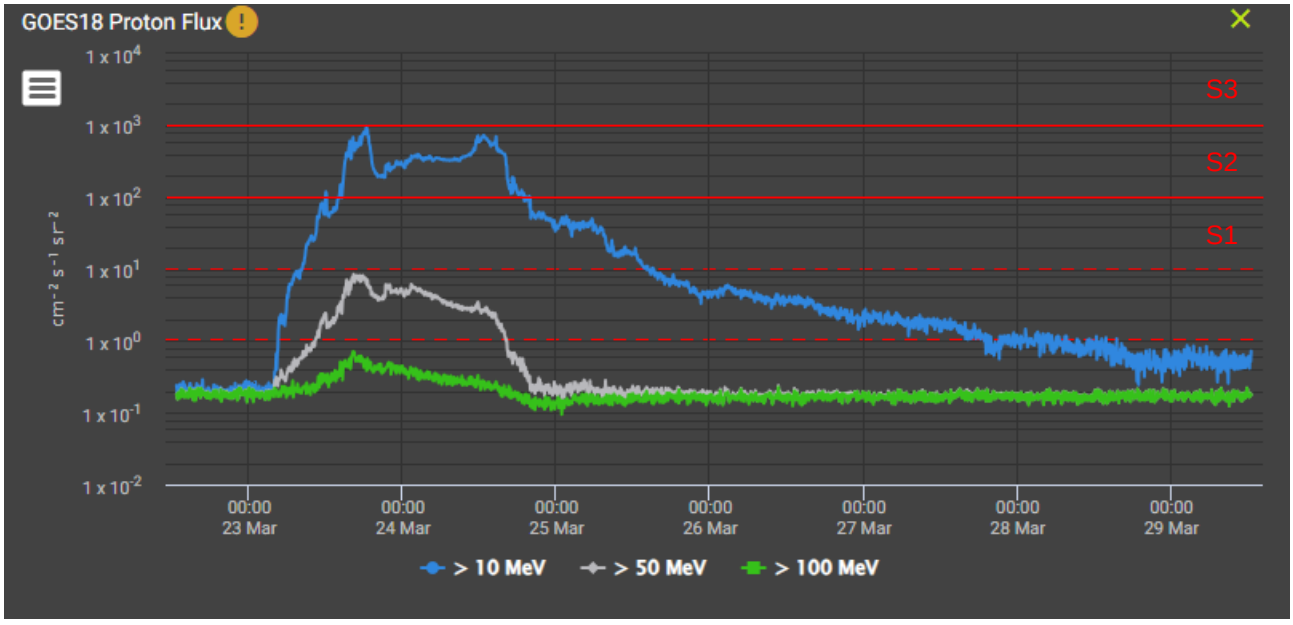
Solar Radiation Storms - (High Energy Protons):

High energy proton flux observed by GOES-18 remains slightly above background but well below the S1 Minor Radiation Storm level. This is due to the declining enhancement after the S2 Moderate Radiation storm that peaked 24 Mar. No proton response was observed from the X1.1 flare on 29 Mar, however any further flares, especially more intense or longer duration ones, could still be eruptive and proton rich especially considering the near west limb location of the region. This region will also continue to give a risk of proton events after rotating beyond the west limb.

There is a slight chance of reaching the S1 Minor Radiation Storm threshold, given any further significant flaring from this region.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-18 Proton flux for the last 7 days (10MeV, 50MeV and 100 MeV)



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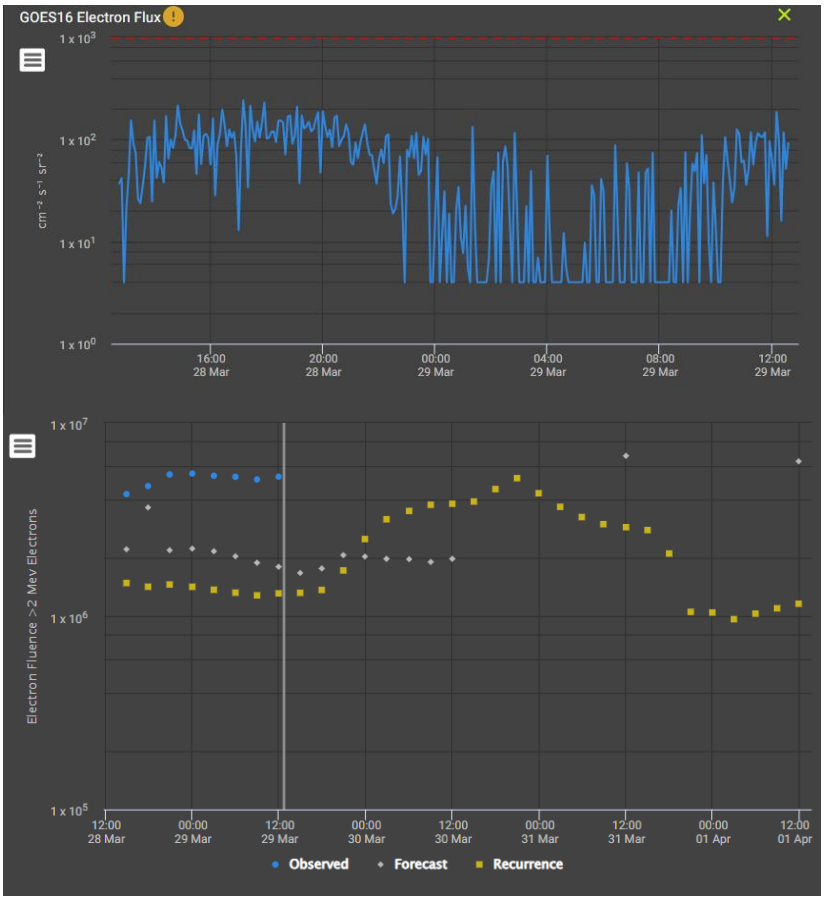
High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 at GEO, has been Background to Moderate, with a modest diurnal increase. This is despite the CME arrival last Sunday (24 Mar), which has likely enhanced electron counts at lower orbitals. Any subsequent enhancement at GEO is looking less likely now, however there remains a chance of count rates giving brief periods Moderate to High flux. Any fast wind connection to CH15/+ is expected to be minimal, and is not expected to increase the risk of seeing further or more prolonged High flux.

The associated 24 hour electron fluence is expected to remain below the Active level, although a rising trend is possible during the period. This is supported by REFM which is considered to be giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >10MeV Electron Flux (top) and associated fluence with REFM (bottom)



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